

IWAKI AMERICA - Walchem

Efficiency Improvements in Plating Shop Operations via Automation

May 2022



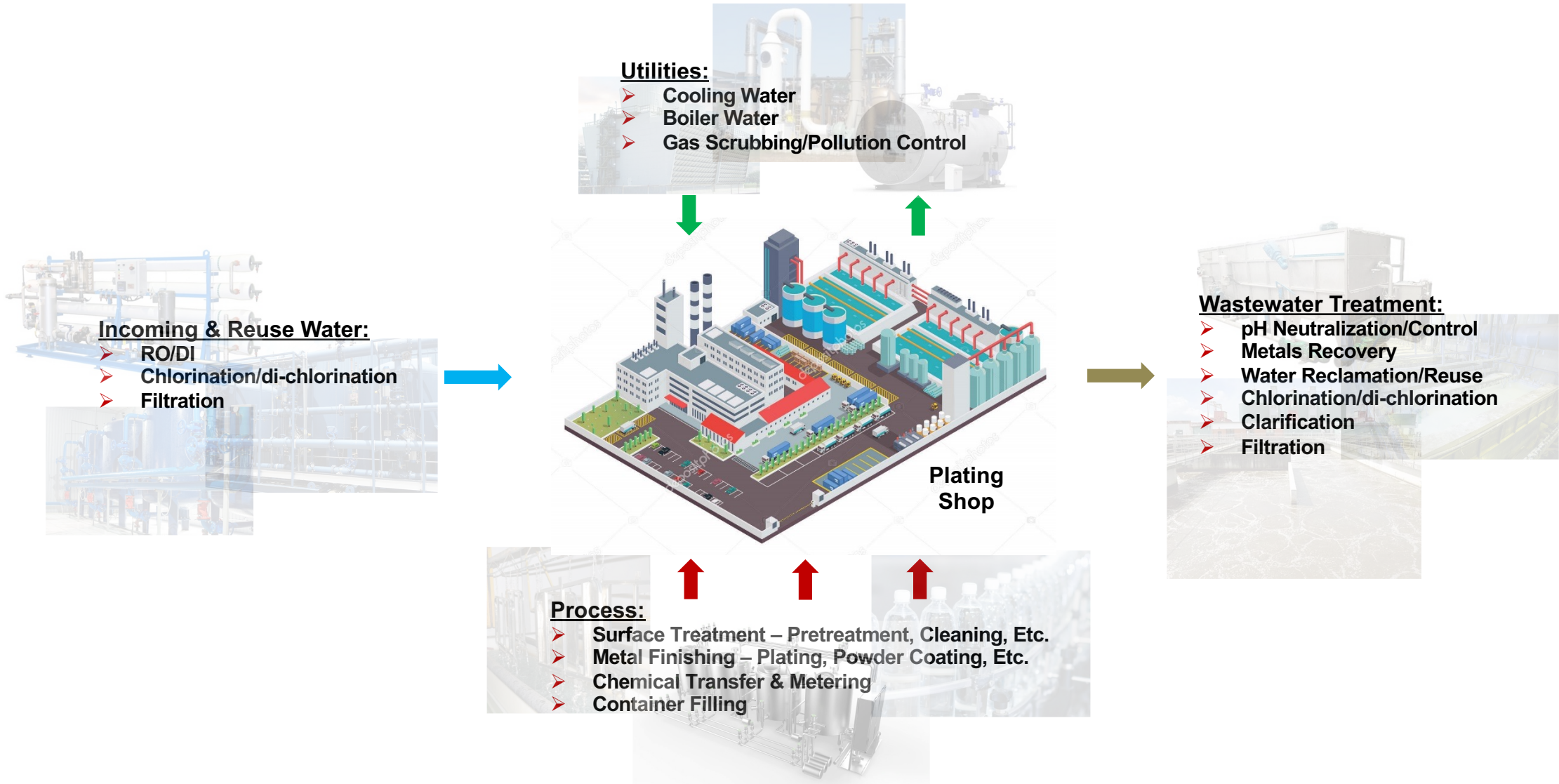
Why Automate?

The Most Damaging Phrase in the Language



Improving Operational Efficiencies

Plating Shop – Chemical Metering & Control Opportunities



Improving Operational Efficiencies

What Are The Opportunities?

- **Process (pre-treatment & final product)**
 - **Improved results**
 - ❑ More robust and stable plating bath
 - ❑ Allows operation within a tighter process window
 - ❑ More consistent plating deposition finish
 - ❑ Real time data collection/warehousing
 - ❑ Real time alarm notification
 - **Time and cost improvements**
 - ❑ Real time analysis reduces time and cost of manual testing
 - ❑ Minimized chemical over/under feed
 - *Better inventory management*
 - *Reduced chemical usage*
 - *Reduced waste*
 - ❑ Resources freed up for other important value-added tasks
- **Incoming and reuse water**
 - **Improved water quality for the process**
 - ❑ Assures a clean surface coming out of the pretreatment part of the process
 - ❑ Minimize potential for spotting, streaking, etc. of the final product surface
 - **Ability to reclaim used water reduces need incoming water**

Improving Operational Efficiencies

What Are The Opportunities?

- **Wastewater**
 - Improved adherence to regulatory permits
 - ❑ Know of a potential problem before it become a problem
 - ❑ Historical data collection – system trend analysis
- **Utilities**
 - Includes cooling towers, boilers, pollution controls (fume scrubbers)
 - ❑ Improved heat transfer
 - ❑ Proper operation of your pollution controls
 - ❑ Longer lifetime of equipment
 - ❑ Legionella control
- **Other**
 - Workforce challenges
 - ❑ Having and keeping the right people in place to do the jobs
 - Competitive pressures
 - ❑ Impact on the bottom line
 - ❑ Global economy
 - *Shops overseas are automating*

Improving Operational Efficiencies

Pretreatment: Industrial Parts Washer Applications

- One of the most important steps in an industrial manufacturing processes
 - Clean, degrease and dry industrial parts
 - Ensures adhesion of intermediate or final finishes
 - ❑ Plating
 - ❑ Anodizing
 - ❑ Powder coating
 - ❑ Paint
- Parts washers vary, but have various stages
 - Run from single to multi-stage systems
 - Stages may include
 - ❑ Wash/Clean stage(s)
 - ❑ Phosphatizing
 - ❑ Sealer stage(s)
 - ❑ Rinse stage(s)



Source: <https://www.bendpak.com/shop-equipment/parts-washers/parts-washers-explained/>



Source: <https://www.internationalthermalsystems.com/2017/07/industrial-parts-washer-division-growing-since-acquiring-continental-equipment-corporation-cec/>

Improving Operational Efficiencies

Pretreatment – What are the Opportunities

MANUAL CONTROLS							CONTROL EQUIPMENT	
Cleaners Rinses	Total Acid	Free Acid	Total Alkali	Free Alkali	A-B/3	Total/Free Ratio	Conductivity	pH
Alkaline Cleaners			X	X	X (1)	X (2)	X	
Acid Cleaners	X	X				X	X	
Cleaner Rinse	X (3)		X (3)				X	X
Conventional Pretreatments	Total Acid	Free Acid	Activator	Accelerator	Zinc	Active Ingredient	Conductivity	pH
Iron Phosphate	X	X (4)					X	X
Zinc Phosphate	X	X	X	X	X		X	
Sealer	X	X				X	X (5)	
Chrome Containing Conventional Pretreatments	Total Acid	Free Acid	Hexavalent Chrome	Accelerator	Total Chrome		Conductivity	pH
Chrome Phosphate	X	X	X	X	X		X	
Chromate	X	X	X	X	X		X	
Rinse	X						X	
Dried-In-Place Pretreatments	Total Acid	Free Acid	Hexavalent Chrome			Active Ingredient	Conductivity	pH
Chrome			X				X	X
Non-chrome		X				X	X	X

- (1) For baths containing high amounts of aluminum
- (2) For baths processing minimal or no aluminum
- (3) Dependent upon the cleaner type
- (4) A reverse of free acid titration can be used instead of pH
- (5) Inorganic chrome post treatment

Adapted from: Powder Coating: The Complete Finisher's Handbook, 4th Edition, The Powder Coating Institute 2012, page 91.

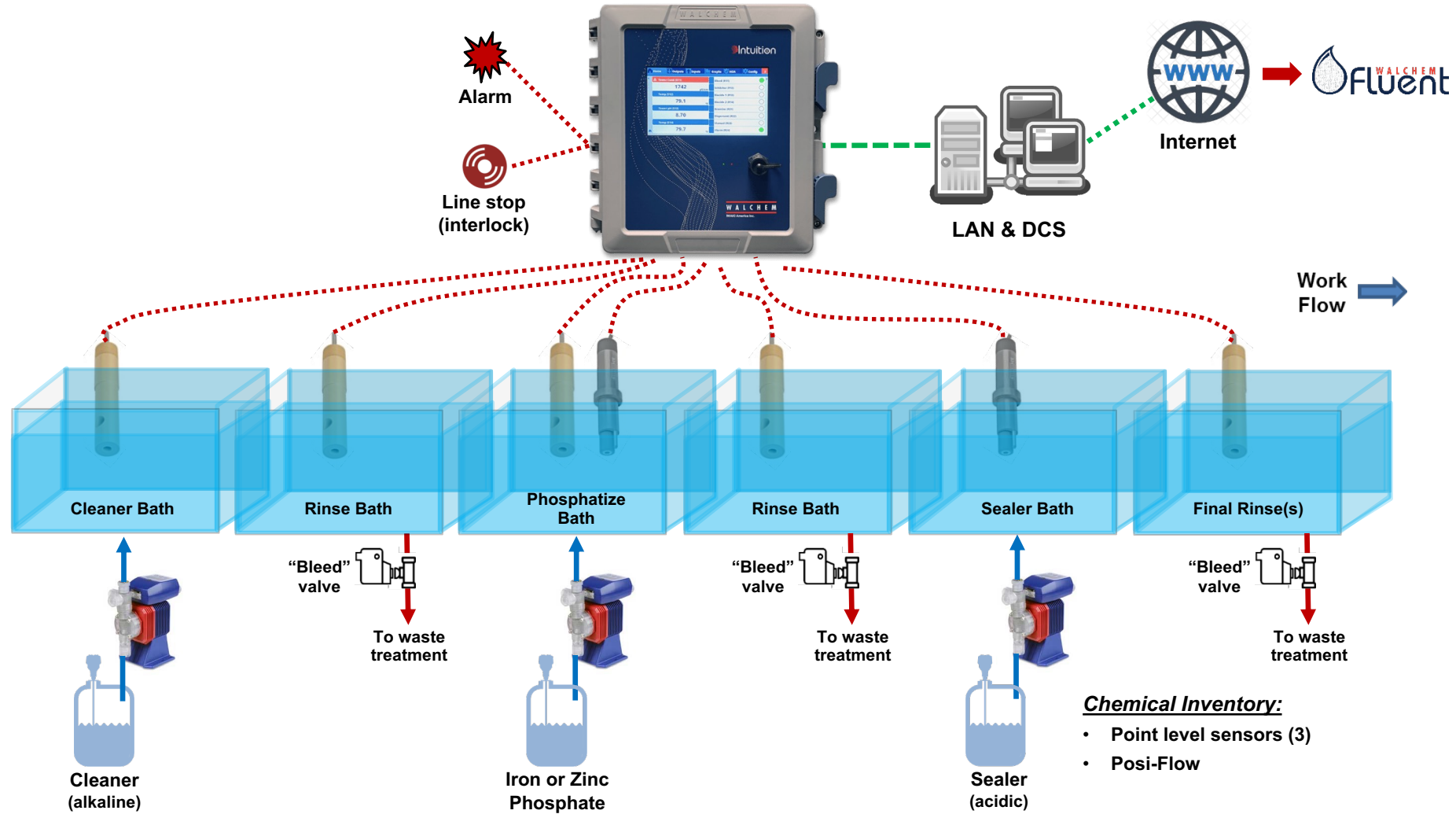
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Industrial Parts Washer - How are stages controlled?

- **Cleaners**
 - **Conductivity – electrodeless**
 - ❑ Titration of % chemical which is correlated to conductivity
- **Phosphate and sealer baths**
 - **Conductivity and/or pH depending on chemistry used**
- **Rinses**
 - **Conductivity – both contacting and electrodeless**
 - ❑ Contacting conductivity sensors typically used when RO water is utilized
 - **pH**
- **Other**
 - **Other parameters of importance**
 - ❑ Temperatures – various stages of the baths
 - ❑ Spray pressures – if using spray system
 - ❑ Part count
 - ❑ Overflow to waste
 - **Historical data can be used for troubleshooting performance problems**

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Metal Finishing Pretreatment: Parts Washer System Installation



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Plating Process Control

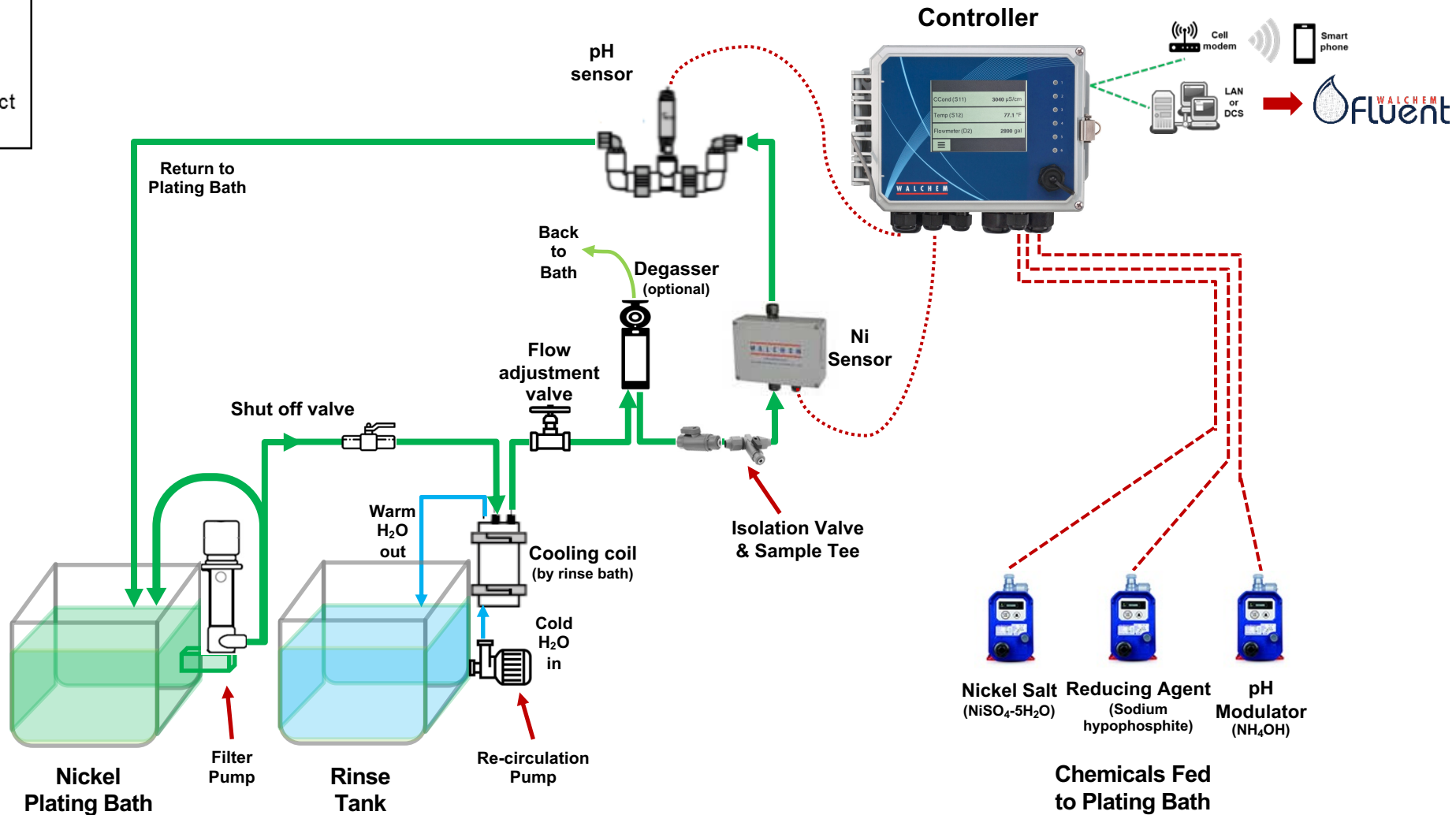
- **Electroplating bath**
 - **Metal concentration by titration or absorbance (Cu, Ni)**
 - ❑ Copper or nickel electroplating baths can be controlled using spectrophotometry
 - *In many cases the metal concentration does not change quickly enough to require automation or too high in concentration*
 - **Electroplating bath pH is frequently monitored and controlled**
 - ❑ Used in Ni plating (pH in the 3.0 to 4.5 range) and Zn plating (pH in the 5.0 to 6.0 range)
 - *End user will in many cases also do a titration to confirm*
 - **Conductivity (electrodeless) – *Hard chrome plating***
 - ❑ **New baths:** ~400-575 mS/cm (based concentration of chromic acid in bath, ~180 to 350 g/L)
 - ❑ As process proceeds, tramp metals build up and conductivity drops
 - *Conductivity determines how effectively and efficiently current or amperage travels through the bath*
 - *Impacts plating quality*
- **Electroless plating bath**
 - **Metal concentration by titration or absorbance (Cu, Ni)**
 - ❑ Readily control copper or nickel in the electroless plating bath using spectrophotometry
 - ❑ Calculation of metal turns (MTOs)
 - **pH controlled in ENi baths**

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Electroless Nickel Bath: Typical Installation for Automating the Bath

Legend:

- Nickel solution flow
- Sensor cables
- Cooling water flow
- AC power or dry contact closure – pump dependent



Improving Operational Efficiencies

Single Electroless Nickel Bath Setup

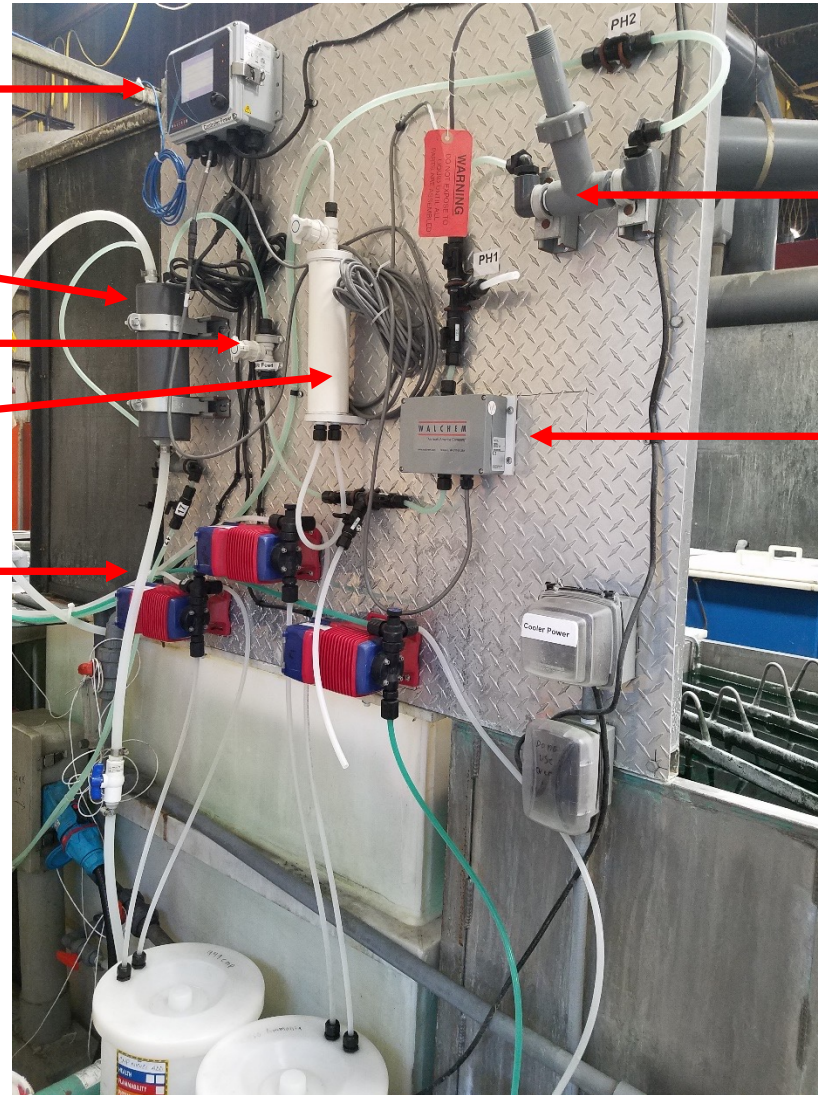
Controller

Cooling
Coil

Flow Control
Valve

Degasser

Chemical
Feed
Pumps

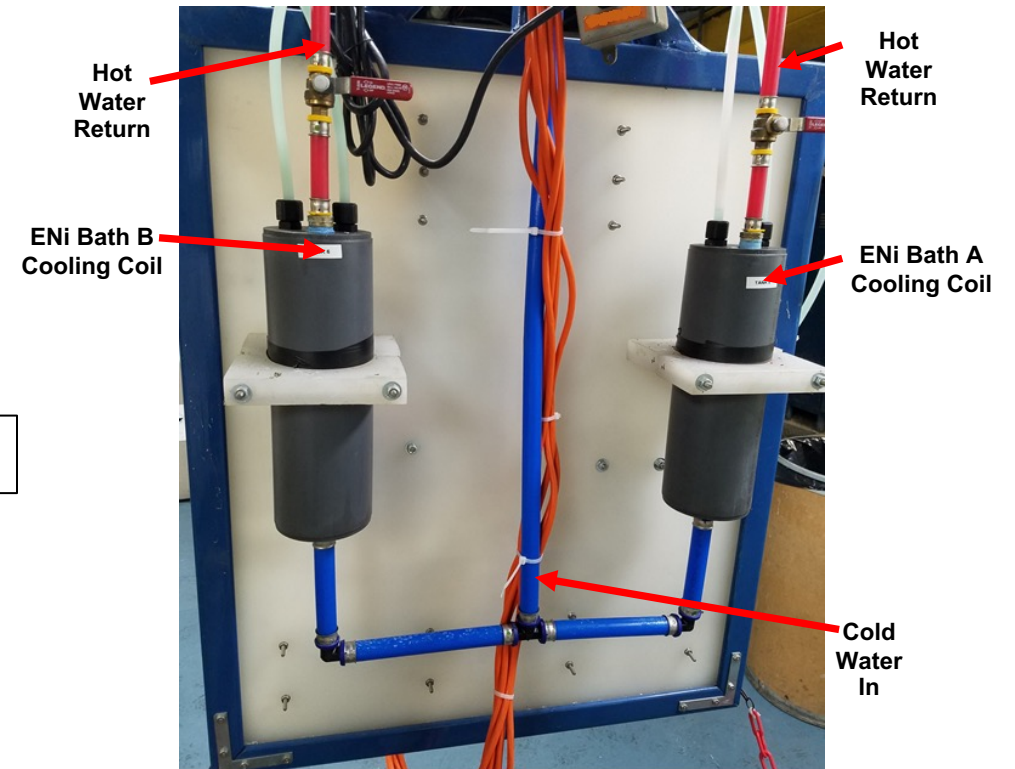
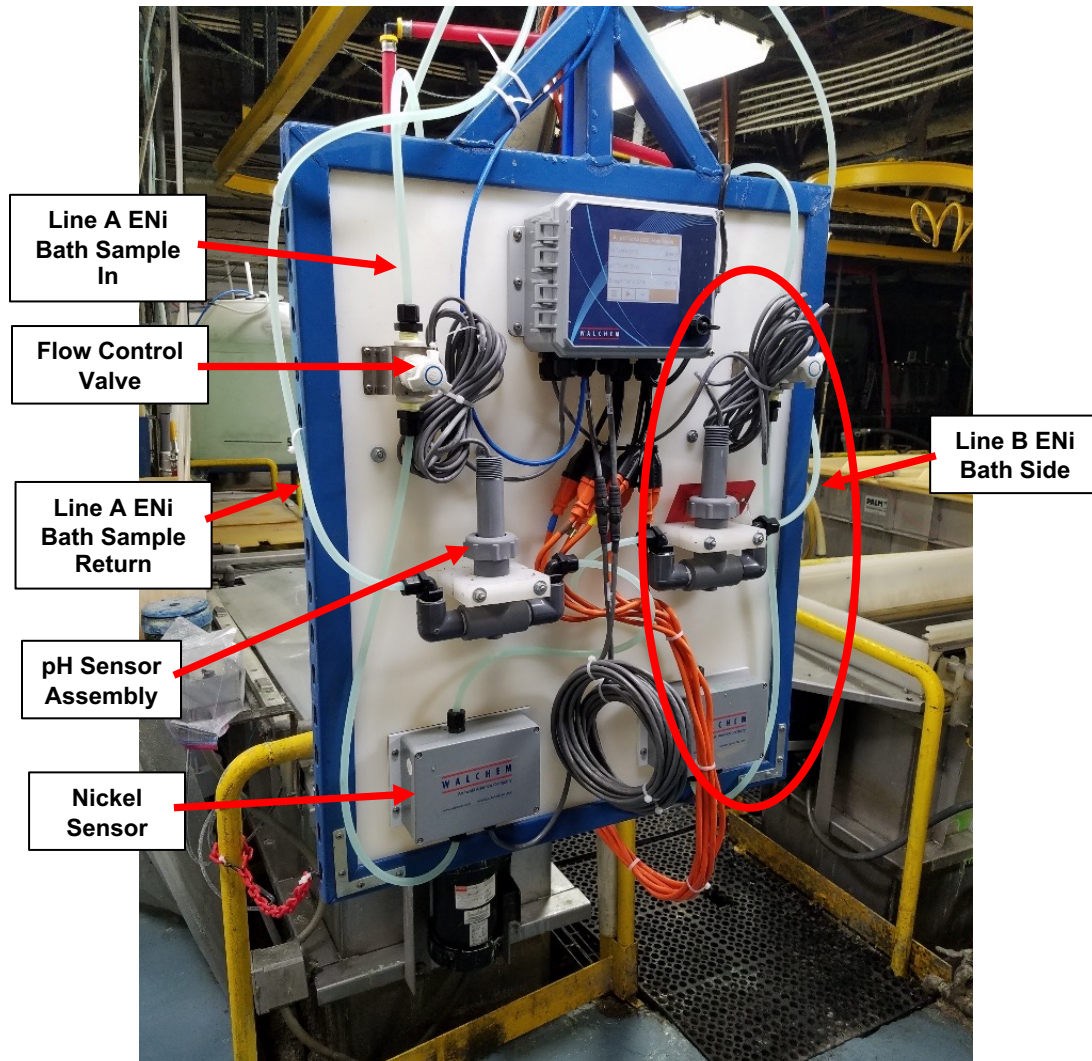


pH Sensor
Assembly

Nickel
Sensor

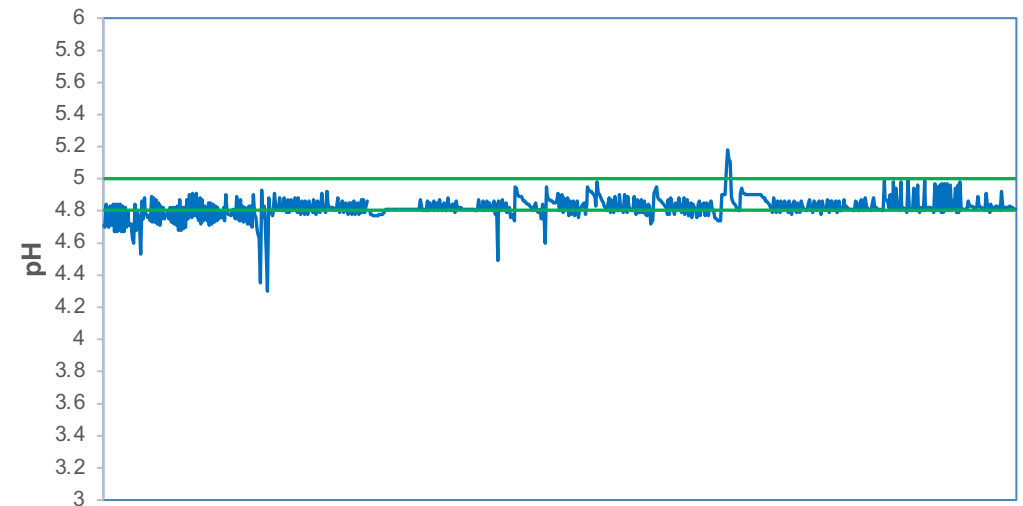
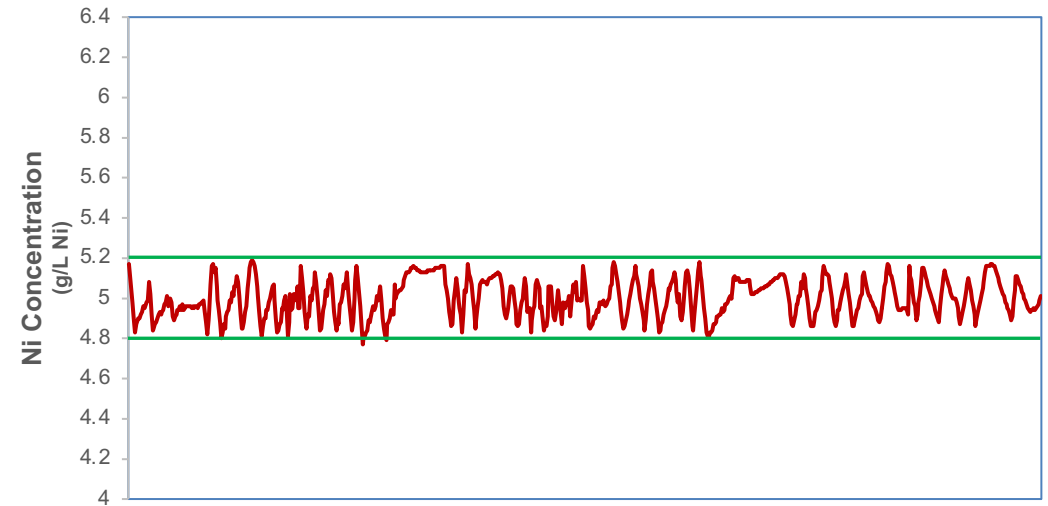
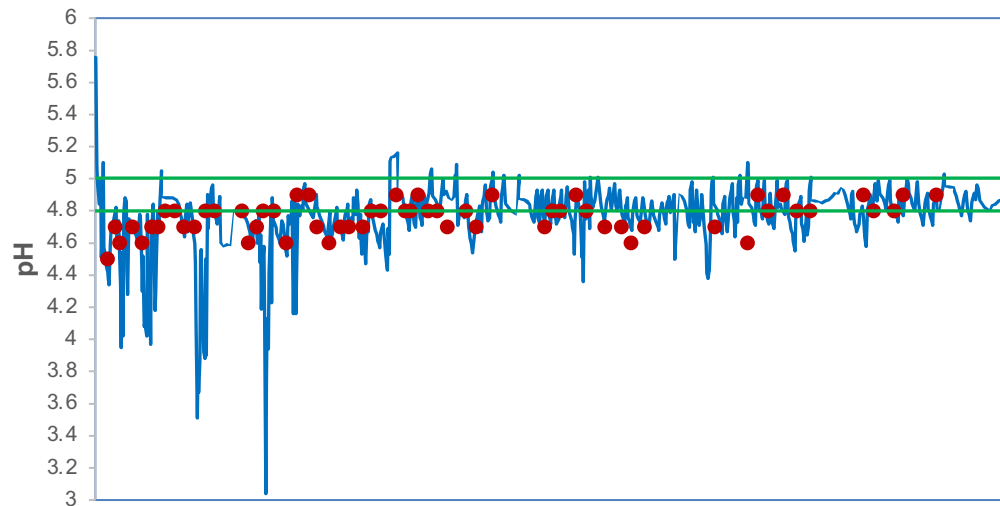
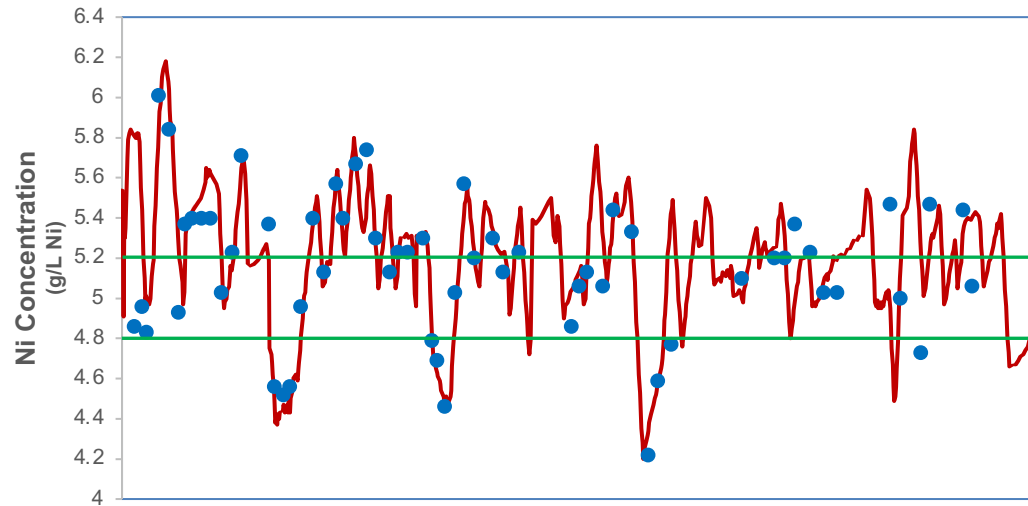
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Dual Electroless Nickel Bath Setup



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Electroless Nickel Bath: Before and After Automation



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Electroless Nickel Bath: Before and After Automation, Final Numbers

- **Nickel manual control results**

- **Plant EDTA titration**

- ❑ Nickel Results: 5.15 g/L
- ❑ Std Deviation: 0.35

- **Controller readings**

- ❑ Nickel Results: 5.19 g/L
- ❑ Std Deviation: 0.32

- **Nickel automated control results**

- **Controller readings**

- ❑ Nickel Results: 5.00 g/L
- ❑ Std Deviation: 0.09

- **pH manual control results**

- **Plant lab**

- ❑ pH Results: 4.8
- ❑ Std Deviation: 0.1

- **Controller readings**

- ❑ pH Results: 4.77
- ❑ Std Deviation: 0.19

- **pH automated control results**

- **Controller readings**

- ❑ pH Results: 4.82
- ❑ Std Deviation: 0.07

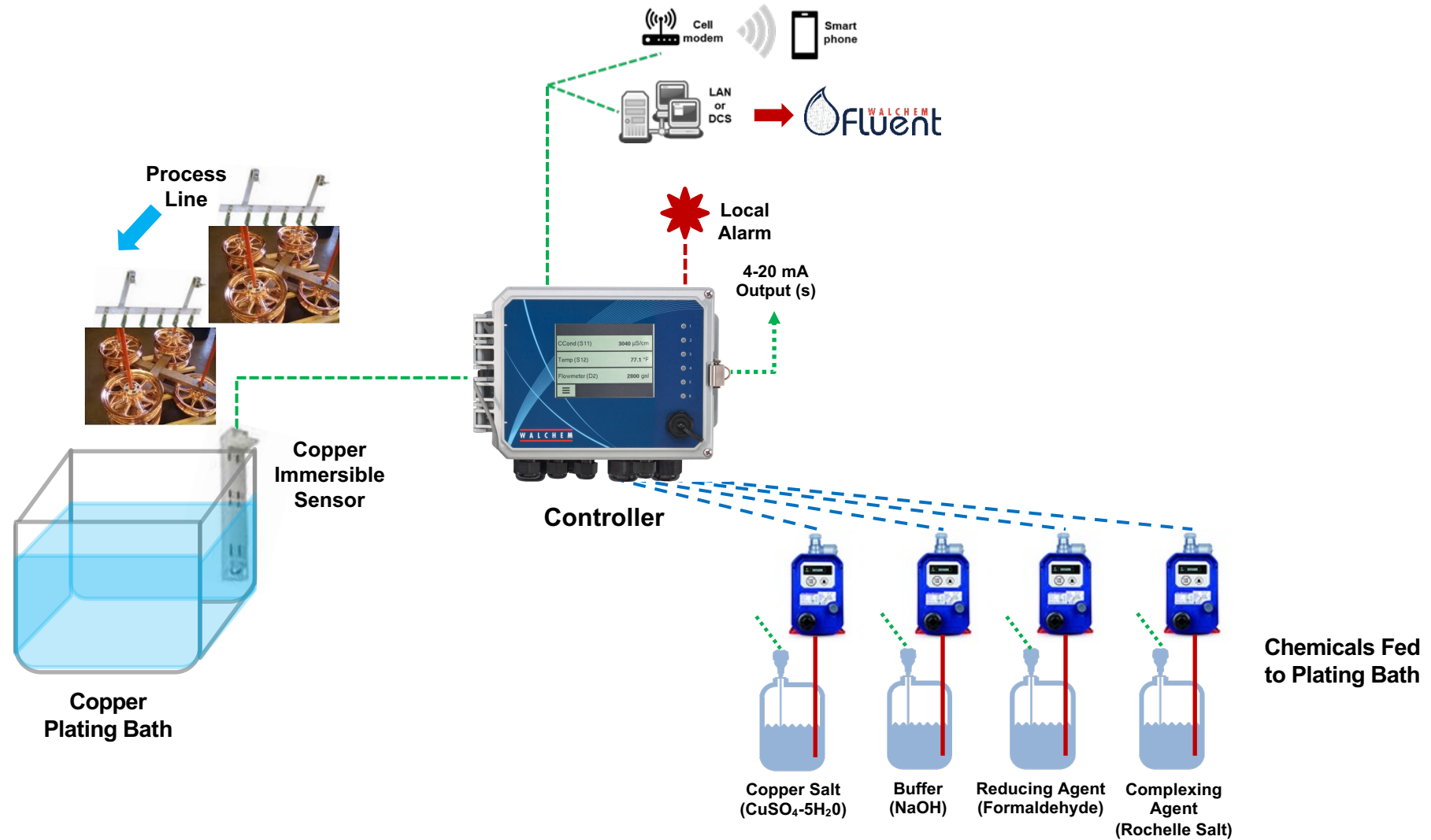
Improving Operational Efficiencies

Plating Shop Benefits Realized via Automation

- **Reduced labor for maintaining automated baths**
 - **Testing time reduced: 75% (compared to pre-automation)**
 - ❑ Operators freed up to focus on other critical aspects of bath operation
 - ❑ Annual cost savings: \$ 2600 to \$ 3900 (per bath)
 - **More consistent quality of plating with less operator interface with bath**
- **Cost reductions**
 - **Total LNS use down 6-8% with the same plating coverage**
 - ❑ This based on only 2 of 6 ENi baths automated - **savings of ~\$100 per every 100 gallons LNS consumed**
 - ❑ Additional savings expected once all baths are automated
 - **Reduced need for manual testing materials – titrations, etc.**
 - ❑ Annual cost savings: \$ 1702 (per bath)
- **Lower percentage of plate out**
 - **Chemistry related plate out on automated baths reduced to near “0”**
 - ❑ Operators more focused on minimizing/eliminating non-chemistry related plate out
- **Longer-term plans for plant**
 - **Automate all ENi baths – eight (8) baths in total**
 - **Automate pretreatment lines – washer & rinse baths**
 - **Upgrade automation on wastewater treatment side**

Improving Operational Efficiencies

Electroless Copper Bath: Typical Installation for Automating the Bath



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Aluminum Anodizing: Where Are the Opportunities for Monitoring & Control?

- **Pretreatment**
 - **Cleaning baths**
 - ❑ Electrodeless conductivity to control alkaline cleaner levels
 - ❑ Metering pumps for alkaline cleaner feed
 - **Etch tanks**
 - ❑ Electrodeless conductivity for etchant chemistry
 - **Rinses**
 - ❑ Conductivity and pH
- **Process**
 - **Anodizing bath**
 - ❑ pH is typically too low to control well with pH controller
 - *Titrations to control level of sulfuric or chromic acid in bath*
 - ❑ Conductivity - electrodeless
 - **Dye baths**
 - ❑ pH can be controlled with pH controller
 - *High temperatures (upwards of 150°F) limits electrode life if no sample cooling is applied*
 - **Sealing baths**
 - ❑ pH may be controlled with pH controller if using acid (other than acetic)
 - *Short electrode life if no cooling*



Source: <https://www.anoplate.com/finishes/hardcoat-anodize/>

Improving Operational Efficiencies

Chromate Conversion Coatings: Where Are the Opportunities for Monitoring & Control?

- **Pretreatment**
 - **Cleaning baths**
 - ❑ Electrodeless conductivity to control alkaline cleaner levels
 - ❑ Metering pumps for alkaline cleaner feed
 - **Rinses**
 - ❑ Conductivity and pH
- **Process**
 - **May be automated via a controller**
 - ❑ Chromic acid controlled by pH (typically 2-3)
 - **Beware of baths with fluoride activators!**
 - Acid fluorides will dissolve the glass pH electrodes
 - ❑ Electrodeless conductivity also can be used
 - ❑ Ion selective electrodes
 - **Chloride and fluoride**
 - **Other components by titration**



Source: <https://www.astfinishing.com/plating-service/chromate-conversion-coating/>



Source: https://en.wikipedia.org/wiki/Chromate_conversion_coating

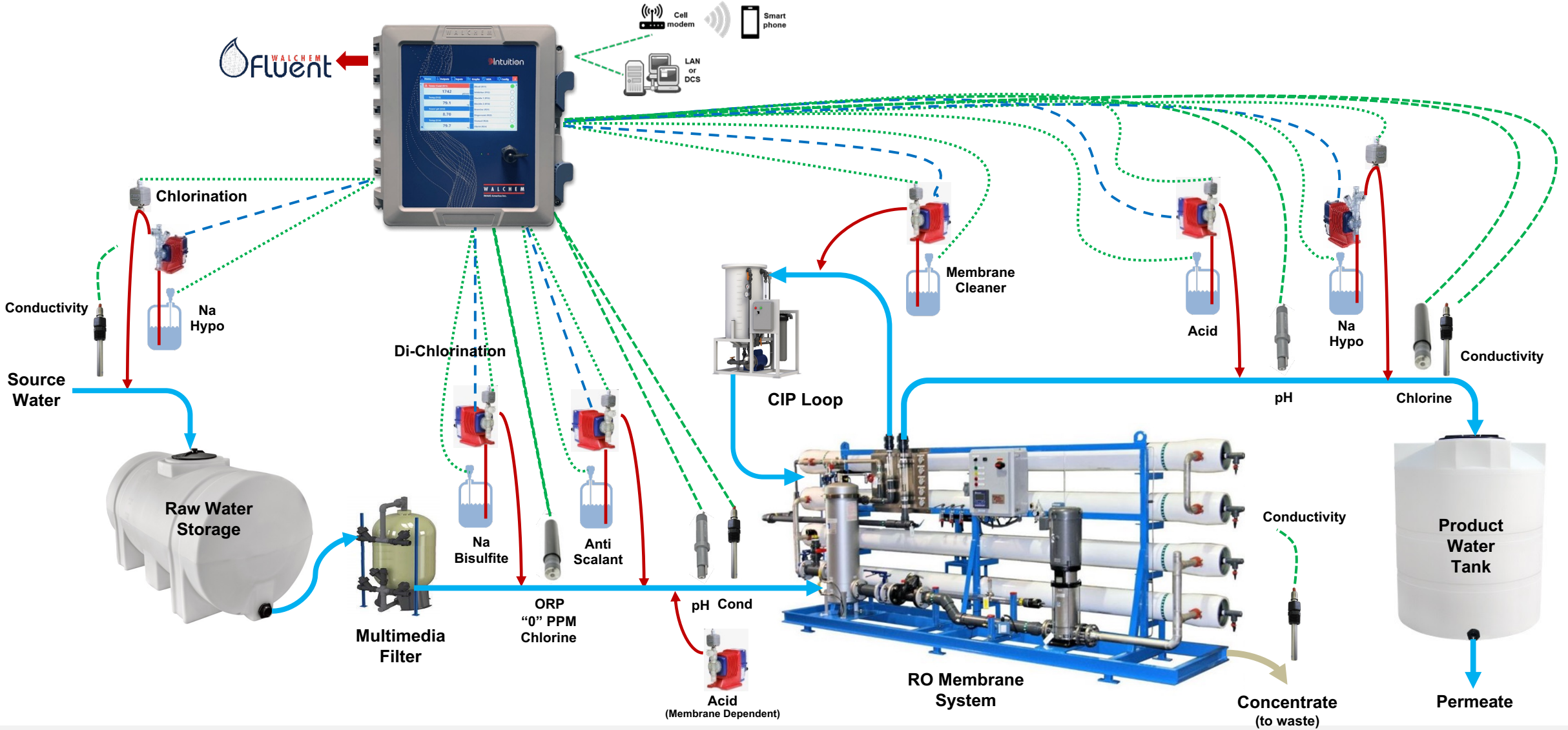
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Incoming & Reuse Water: What Are The Opportunities?

- **Incoming and reuse water**
 - **Where this is important**
 - ❑ Purification of water supply for process needs
 - ❑ Recovery of chemicals from plating drag out
 - ❑ Wastewater purification and reuse
 - **Improved water quality for the process**
 - ❑ Assures a clean surface coming out of the pretreatment part of the process
 - ❑ Minimize potential for spotting, streaking, etc. of the final product surface
 - **Increased membrane operational lifetimes in RO system**
 - ❑ De-chlorination step
 - **When applied to plating drag out**
 - ❑ Allows for return of chemical concentrate (recovered chemical solution) to process bath
 - *Valuable process chemicals may be recovered*
 - *Recovery of metals to meet metal discharge limits.*
 - ❑ Reuse of the permeate (purified water) as fresh rinse water
 - *Less fresh water is needed – lower water costs*
 - ❑ Minimizes or eliminates water discharge to the POTW (publicly owned treatment works)

Incoming & Reuse Water

RO Installation Application



Improving Operational Efficiencies

Utilities: What Are The Opportunities?

- **Utilities**

- **Cooling towers**

- ❑ Reduced water consumption allows for recycling most of the water used in process cooling or air conditioning
 - ❑ Potential for sewer credits due to evaporative losses
 - ❑ Reduced chemical usage
 - *Savings often outweigh the water reduction savings*
 - ❑ Reduced corrosion and scale formation
 - *Longer equipment lifetime*
 - ❑ Legionella control

- **Boilers & condensate return**

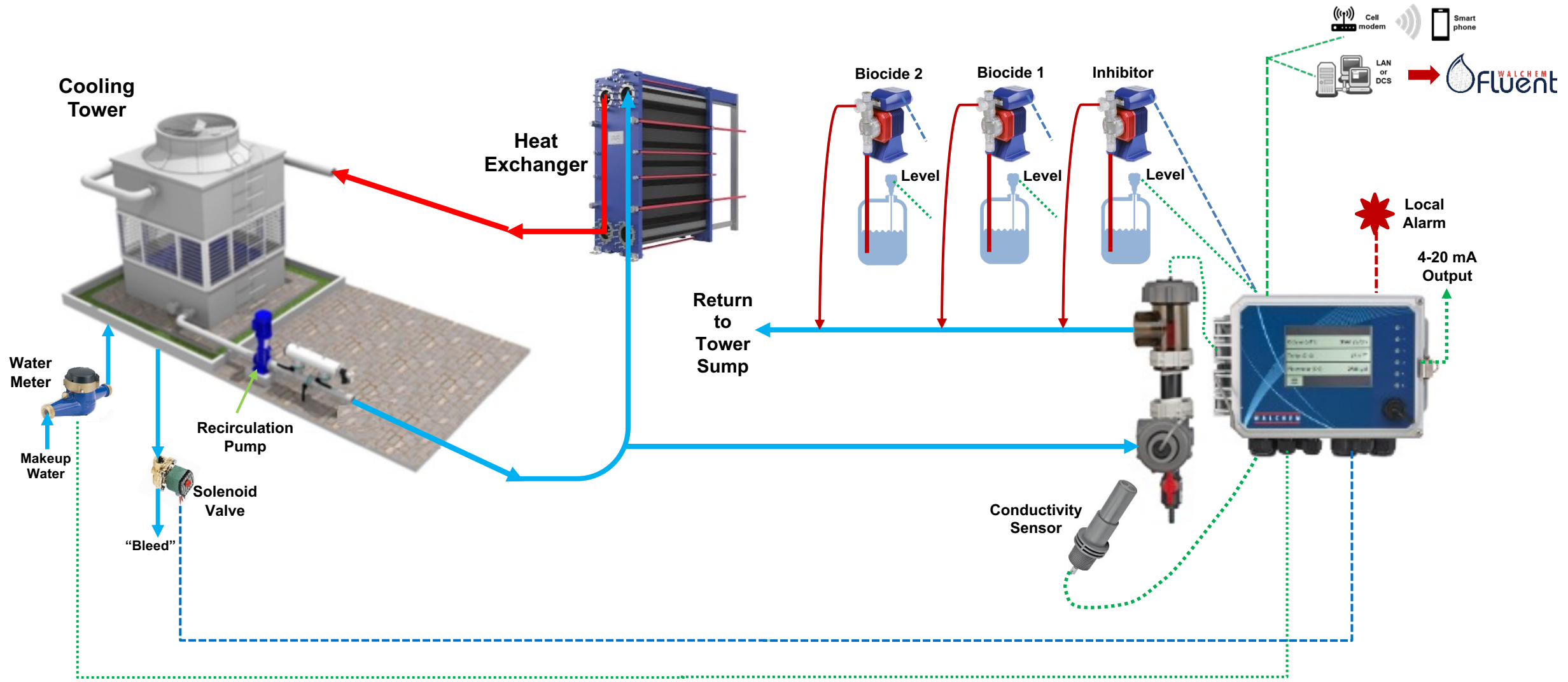
- ❑ Improved heat transfer
 - ❑ Reduced corrosion and scale formation
 - *Longer equipment lifetime*
 - ❑ Energy savings – via proper control of condensate return to boiler feed water
 - *Also reduces chemical, make up water & sewer disposal costs*

- **Pollution controls – fume scrubbers**

- ❑ Minimization/elimination of pollutants and/or odors
 - ❑ Keep workers safe
 - ❑ Regulatory compliance – nonadherence to emission requirements results in high fines!

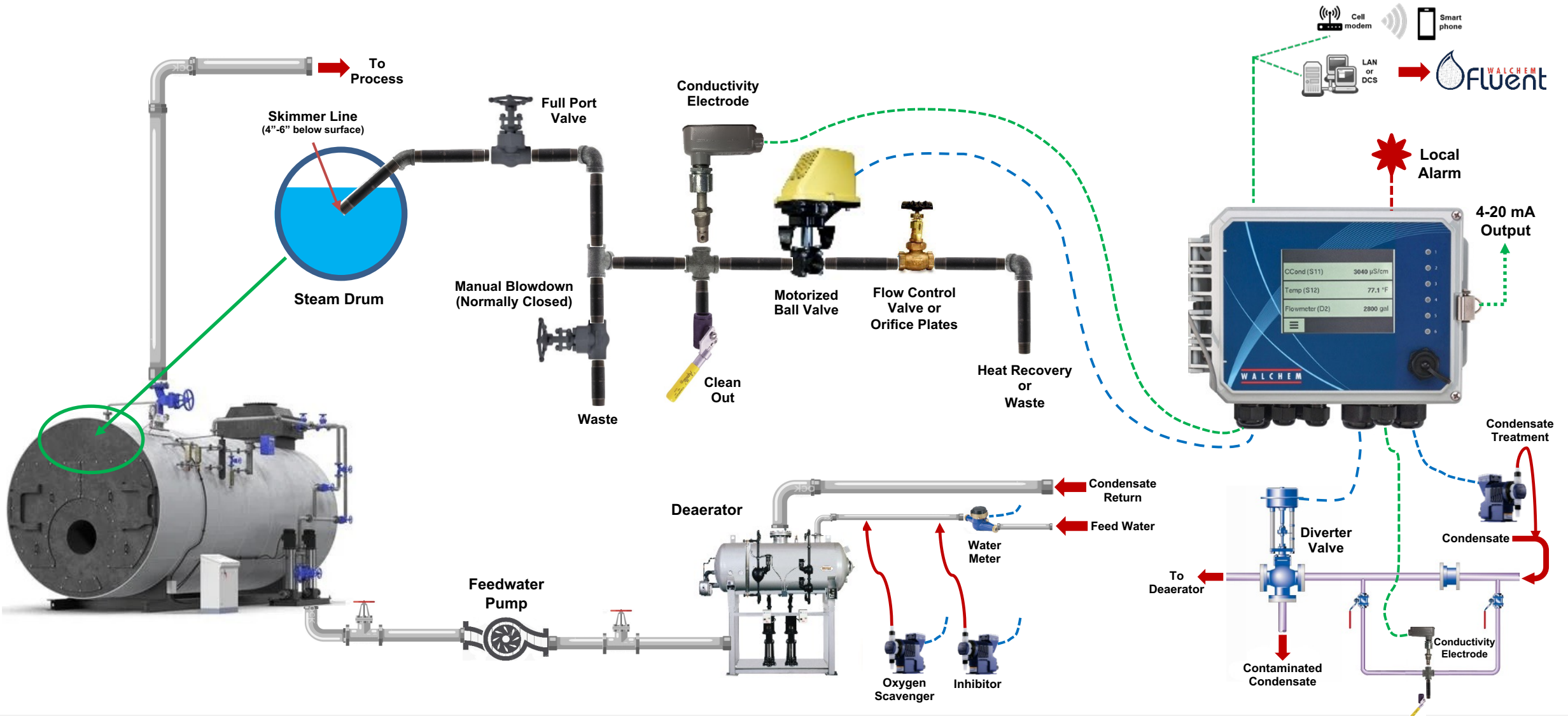
Markets & Applications

Industrial, Utilities - Cooling Tower Application



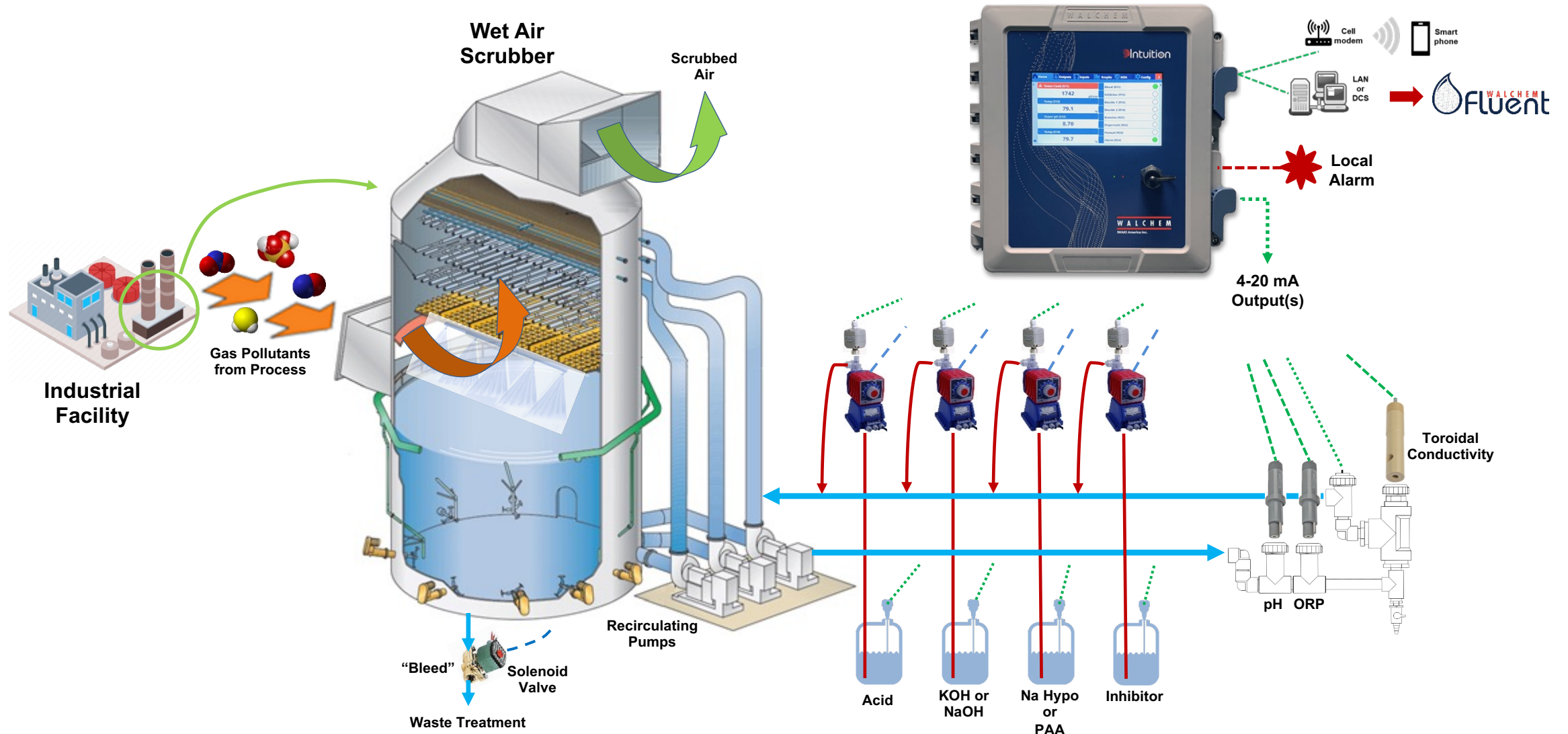
Markets & Applications

Industrial, Utilities – Boiler System & Condensate Return Application



Markets & Applications

Industrial – Utilities: Wet Air Scrubber Application Installation



Improving Operational Efficiencies

Wastewater: What Are The Opportunities?

- **Wastewater**

- **Improved adherence to regulatory permits**

- ❑ Know of and resolve a potential problem before it become a problem
- ❑ Avoid fines due to noncompliance

- **Reduced energy costs**

- ❑ Recovery and reuse of water throughout the plant

- **Process improvements**

- **Constant access to data**

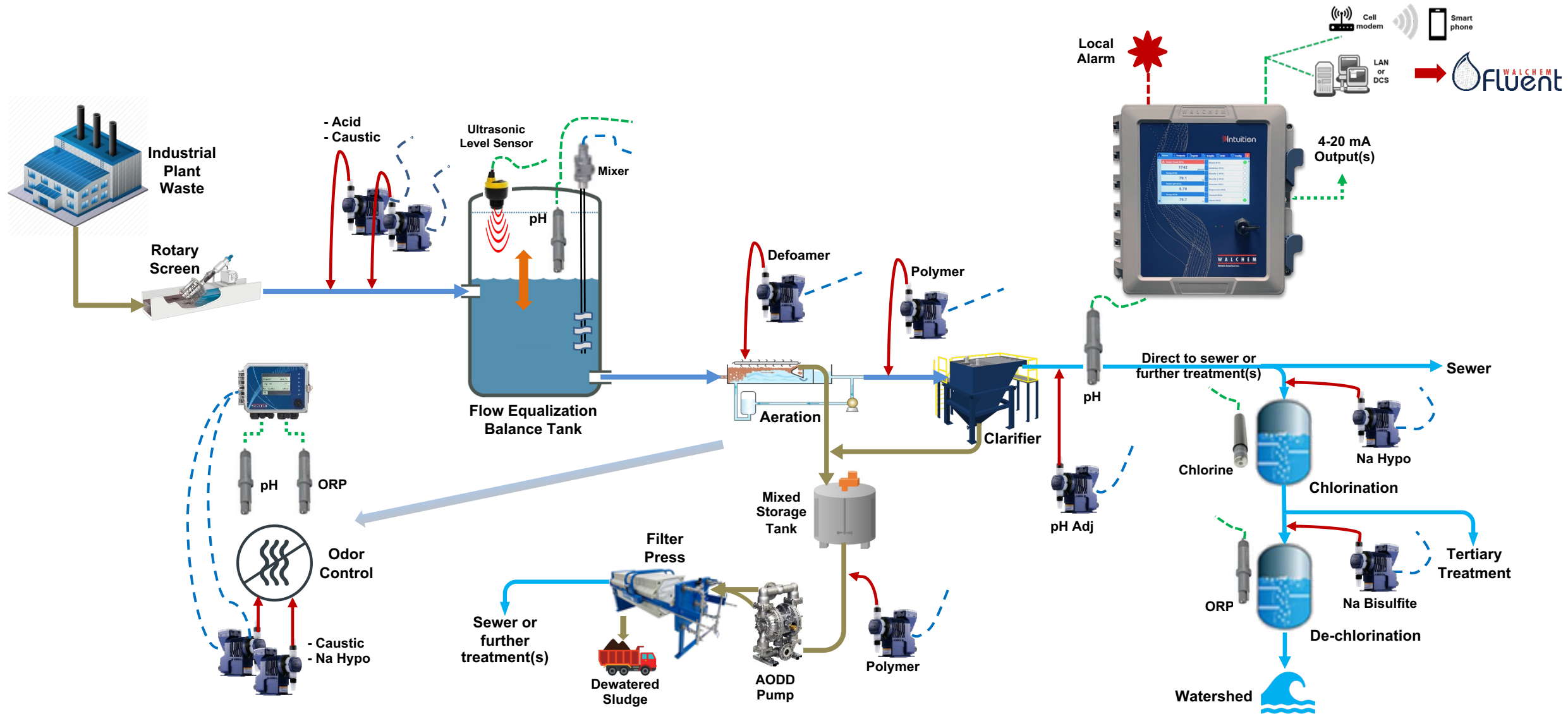
- ❑ Increasing the wastewater process efficiencies
- ❑ Ability to better evaluate trends and how different patterns emerge in both low and high usage times
 - *Better make use of resources*

- **Better use of labor**

- ❑ Allows better use of your human capital to more value added and important tasks and issues

Markets & Applications

Industrial – Wastewater: Wastewater Treatment Installation



Improving Operational Efficiencies

Summary

- **More robust process operation**
 - Improved consistency of plating rate and bath stability
 - More uniform deposit
 - Allows operation within a tighter process window
 - Overall higher quality to better meet your customer requirements
- **Time and cost reductions**
 - Both in testing time and expense and overall tank maintenance
 - Water, energy and chemical usage improvements
 - Longer equipment lifetimes
- **Ability to see “real-time” data and alarm notifications**
 - Ability to quickly respond to a process upset
 - Anywhere and anytime
 - Minimize/eliminate potential for non-compliance with permits
- **Improved efficiencies**
 - Free up resources to perform other important and value-added tasks

Open Discussions

Questions & Answers & Discussions



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THANK YOU

